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# THE MANUFACTURE OF CAMEMBERT CHEESE.

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## DEVELOPMENT OF THE CAMEMBERT-CHEESE INDUSTRY.

Camembert cheese was first made by Marie Fountain in 1791, at Camembert, near Argentan, in the Department of Orne, in northwestern France, but it was not until some years later that the cheese was made on an extensive scale. The industry soon extended into Calvados, and these two Departments are still the principal seats of the industry.

The first factories built in the United States were copied after those of Europe and experienced cheesemakers were brought to this country to carry on the work. Early attempts to establish the industry here were for the most part failures. The commercial manufacture of Camembert cheese, in fact, presents many difficulties. Success can be attained only by experience, by close attention to details, by proper curing conditions, and by the use of pure cultures, for without such cultures the product is defective and there are great losses. The American manufacturer found it difficult to produce cheese of a quality to compare with that made in France, as well as to meet the foreign competition in price, even with freight and duty charges added to the cost of the imported product. This com-

petition resulted in uncertain markets and prices for domestic cheese, and as a consequence frequent losses to the manufacturer. Thus there was little to encourage the industry in this country.

Just prior to the World War only about one-fourth of the Camembert used in the United States was made in this country; the remainder was imported from France, save a few thousand pounds of tinned cheese brought from Germany. In 1914 about 1,500,000 pounds of cheese was received from France, the bulk of which was Camembert. Shutting off nearly all the imported cheese during the war period gave the American manufacturers much needed experience in handling this product. At present there are in the United States at least 10 factories making this kind of cheese; and the larger ones are successfully producing from 12,000 to 35,000 pounds a month during the flush of the Camembert season. Most of this manufacture is in New York, Illinois, Michigan, and California. The increased demand for Camembert during the last few years may possibly be explained by the American soldiers becoming acquainted with the cheese during their sojourn in France. The prevailing high price of the cheese has also stimulated the industry.

Much progress has been made in recent years by way of improved curing conditions and in the understanding of the principles involved in making and marketing the product. The processes of manufacture now employed in most factories are so modified that in many instances they are quite different from those originally used in France. This bulletin discusses modern methods used in the United States in manufacturing and marketing the cheese, together with the precautions necessary and the difficulties often encountered in establishing a factory.

## CHARACTERISTICS OF CAMEMBERT CHEESE.

A Camembert cheese is usually $4\frac{3}{8}$ inches in diameter and from about 1 to $1\frac{1}{4}$ inches thick. The surface of the cheese should be covered with a thin velvetlike growth of blue-gray mold and other microorganisms. The blue-gray mold is responsible for the Camembert flavor, and at first it wholly covers the cheese. With it, however, appears another growth, which is reddish yellow and produces a moist layer technically called slime. The finished cheese should be largely reddish yellow, interspersed with patches of the blue-gray Camembert mold (*Penicillium camemberti*); sometimes the mold predominates, and sometimes the reddish slime does. A thick coat of the blue mold with little or no slime is undesirable, as it indicates improper ripening. The slimy growth should gradually spread itself over the cheese during the final stages of ripening. A crinkly surface, distinct from the regular impressions formed by the matting or ripening boards, is undesirable, as it is a sign that the cheese has not been ripened under proper conditions. Such a cheese, especially if moist, often emits a strong odor and is to be avoided.

Just beneath the rind of the cheese there is a progressive ripening which starts from the surface and moves toward the center. This change is indicated by the color being more yellow than that of the unripened portions, while the taste is more sour. The ripening is caused by enzyms which are produced by the mold.

The quality of Camembert mold may be judged fairly well by its appearance. In general, the intensity of the flavor increases with

the softness of the cheese; very soft cheese is often strong flavored. The odor and flavor of Camembert, however, are not repulsive, like those of other closely related varieties, provided the manufacturing process has been carried out properly. An extremely sticky surface in conjunction with a very soft texture is often associated with strong, biting flavors, whereas if the cheese surface is more dry there is usually a milder, sweeter, and more delicate flavor. Strong odors of ammonia are usually an indication of overripeness. An ideal Camembert cheese should emit an odor sweet and agreeable, in contrast with the odors of decay sometimes noticeable in overripe and improperly handled cheese.

## FOOD VALUE.

Camembert cheese has a lower nutritive value than full-cream cheese, because of its somewhat higher water content and slightly lower fat content; nevertheless this cheese compares favorably with other nitrogenous foods in percentages of fat, protein, and ash. According to the Bureau of Home Economics the digestibility of Camembert cheese is practically the same as that of cream cheese. Like other varieties of soft cheese, it is higher in price pound for pound than the harder kinds of cheese. Camembert, however, is eaten more for its flavor and to give variety to the diet than for its value as nutriment.

## COMPOSITION OF CAMEMBERT CHEESE.

The composition of good grades of Camembert cheese is fairly uniform with respect to fat, protein, and water. Normally the water content of a cheese is about 50 per cent, fat 28 per cent, and protein 20 per cent. The remaining 2 per cent consists of salt, ash, etc. Figures given by Thom [1] on the composition of 12 cheeses are shown in Table 1. Ten of these were imported; Nos. 8 and 9 were made in the United States.

TABLE 1.—*Analyses of Camembert cheese in American markets.*

| Sample No. | Water. | Fat. | Protein. | Proportion of fat to protein. |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | |
| 1 | 47.50 | 26.30 | 21.80 | 1 : 0.82 |
| 2 | 45.59 | 27.71 | 21.40 | 1 : .77 |
| 3 | 46.36 | 27.78 | 21.21 | 1 : .76 |
| 4 | 48.41 | 27.01 | 19.36 | 1 : .71 |
| 5 | 48.79 | 26.72 | 18.75 | 1 : .71 |
| 6 | 43.08 | 32.13 | 21.27 | 1 : .66 |
| 7 | 44.25 | 31.09 | 19.69 | 1 : .60 |
| 8 [a] | 50.59 | 26.30 | 18.83 | 1 : .71 |
| 9 [a] | 47.03 | 26.67 | 20.32 | 1 : .73 |
| 10 | 54.41 | 23.04 | 16.83 | 1 : .73 |
| 11 | 51.23 | 25.68 | 17.61 | 1 : .68 |
| 12 | 47.69 | 27.32 | 19.05 | 1 : .69 |
| Minimum | 43.08 | 23.04 | 16.83 | 1 : .60 |
| Maximum | 54.41 | 32.13 | 21.08 | 1 : .82 |
| Average | 47.91 | 27.33 | 19.66 | 1 : .71 |

[a] Domestic cheese.

[1] Charles Thom. 1909. Camembert Cheese Problems in the United States. U. S. Department of Agriculture, Bureau of Animal Industry, Bulletin 115. Page 15.

These figures show clearly that it is possible to standardize the milk at about 3.6 per cent of fat by removing fat in excess of that percentage and still maintain a ratio of fat to protein as high as that found in the imported cheese.

Domestic Camembert at present runs somewhat higher in moisture than the average of Table 1, which is probably because it is marketed at an earlier date than it is possible for the imported cheese to be placed on our markets. The chief factors which influence the keeping quality of Camembert are the water content and to a less extent the salt content. Table 2 shows the composition in respect to water and salt of eight samples of domestic cheese, as recently determined in the Dairy Division laboratories. The samples were selected at random on the market, without reference to their quality. Probably the average cheese runs somewhat higher in moisture content now than 10 years ago. These samples of domestic Camembert represent cheese only partially ripened. A high percentage of domestic cheese reaches the consumer only partially ripened, whereas the imported cheese usually is completely ripened. Probably the bulk of domestic cheese is marketed before it is half ripened. The nature of the wrapping, whether tin foil or paper, and the age of the cheese, are factors influencing slightly the water content of the cheese.

TABLE 2.—*Water and salt in 8 samples of domestic Camembert cheese.*

| Sample No. | Water. | Salt. | Sample No. | Water. | Salt. |
|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | | *Per cent.* | *Per cent.* |
| 1 | 54.44 | 3.05 | 6 | 48.24 | 3.48 |
| 2 | 53.65 | (1) | 7 | 50.12 | 3.63 |
| 3 | 52.18 | 2.95 | 8 | 54.84 | 2.53 |
| 4 | 50.37 | 2.85 | | | |
| 5 | 54.88 | 3.00 | Average | 52.34 | 3.07 |

[1] Not determined.

The salt in Camembert cheese is used not only because of its effect on taste, but also because it performs a function in the ripening of the cheese itself. Under normal conditions salt, more than any other factor in the curing process, acts as a restraining agent against *Oidium lactis*. A small percentage of moisture is removed from the cheese and drains away as a result of the salting. Part of the salt is absorbed by the cheese, and part passes off in the whey. The action of the salt results in a slight crust, which likely contains a higher salt content than the interior of the cheese. Gradually the salt diffuses throughout the cheese until a salt equilibrium is established. A high temperature, with a salting period too long postponed, may result in such a development of *Oidium lactis* that the cheese will fail to absorb the salt properly and the oidium will prove injurious to the cheese. Under normal conditions, however, the salt tends to check the development of this destructive organism and maintains a healthy surface for the subsequent development of the Camembert mold and the normal reddish slime.

In order to determine the percentage of salt found in imported cheese six samples were carefully selected and were analyzed for water and salt. Table 3 shows the result of these analyses.[2]

[2] Charles Thom, J. N. Currie, and K. J. Matheson. 1914. Studies Relating to the Roquefort and Camembert Type of Cheese. Bulletin 79, Storrs Agricultural Experiment Station, Storrs, Conn.

TABLE 3.—*Water and salt in 6 samples of imported Camembert cheese.*

| Sample No. | Water. | Salt. | Sample No. | Water. | Salt. |
|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | | *Per cent.* | *Per cent.* |
| 1 | 48.10 | 2.25 | 5 | 48.38 | 2.32 |
| 2 | 47.98 | 2.18 | 6 | 47.06 | 3.07 |
| 3 | 49.34 | 2.34 | | | |
| 4 | 47.95 | 3.04 | Average | 48.13 | 2.63 |

A typical ripe Camembert cheese should contain approximately 50 per cent water and 2.5 per cent salt. Undersalting may result in a cheese with undesirable flavors, while oversalting may become offensive to the taste.

Most imported cheese contains from 47 to 50 per cent moisture, while the domestic cheese probably averages between 50 and 53 per cent. A cheese with a good keeping quality should contain less than 50 per cent moisture when fully ripened. Some of the fully ripened cheese acquires a strong, disagreeable odor and flavor of ammonia. Drying the cheese so that it will contain less than 50 per cent moisture necessitates a longer curing period than is commonly used in this country, and greater allowance must be made for shrinkage so that each cheese will completely fill and snugly fit its box.

The size of the cheese, the presence or absence of foreign molds, the proper proportion of Camembert mold and reddish slime, and the degree of firmness and ripeness are the most common factors in judging the quality of a Camembert cheese on the market.

## QUALITY OF MILK REQUIRED.

Fresh, clean milk is essential for success in the manufacture of Camembert cheese. Normally the acidity of the milk may be judged by testing with one-tenth normal sodium hydroxid. Where difficulty is experienced in holding in check gassy fermentation, the use of the methylene-blue reduction test is advised as a method of selecting milk suitable for the manufacture of this cheese.

## THE MAKING PROCESS.

### STANDARDIZING THE MILK.

It is usually advisable to skim milk testing high in fat for making Camembert cheese. The milk may be skimmed to not less than 3.5 per cent fat without injury to the quality of the cheese. Some may skim to a lower point than this, but it is not advisable to do so, because skimming too close will impair the quality of the cheese by causing it to become too hard and dry, and, further, because fat made into Camembert cheese may usually be sold as profitably as when made into butter, or even more so. The Federal standard requires that the cheese contain 45 per cent of fat in the dry matter.

### QUANTITY OF STARTER TO USE.

From 1 to 2 per cent of an active commercial starter is advised for the making of Camembert cheese. Buttermilk starter has been used occasionally, but a reliable commercial starter is more depend-

able. In some cases 2 per cent of starter as mentioned above is preferable. The proper amount depends somewhat upon the method employed in making the cheese. Under normal conditions, however, 1 per cent of a starter is advised, even though it may be necessary to ripen the milk to 0.20 or 0.22 per cent, calculated as lactic acid, before the addition of rennet. A slow-acting starter may be so inefficient as to cause total loss of the cheese, and for this reason great care must be employed in keeping the starter in a vigorous condition.

The use of a starter is to prevent gassy fermentation, but there are times, especially in the spring and fall of the year, when the milk has ripened so far that the introduction even of large quantities of starter will prove fruitless, and for that reason the milk for making Camembert must be carefully inspected.

### THE ACIDITY OF MILK AT RENNETING.

At setting, the milk should have from 0.20 to 0.23 per cent acidity as determined by one-tenth normal sodium hydroxid. French authorities advise from 0.20 to 0.21 per cent acidity at this period.[3] There are variations in the initial acidities of milk during the different periods of the year. Highly acid milk is undesirable. The acid itself may not be very objectionable, yet, because it increases the danger of gassy fermentation subsequently, it is to be avoided. Whenever a cheese is gassy it drains slowly, the whey is not clear, and more difficulty is experienced in turning and ripening than with a normal cheese. A few gas holes are not objectionable, but when the cheese is spongy with gas, the flavor, texture, and appearance are often so impaired that it is impossible to market the product.

In some instances where the cheese is rather dry and ripened at a high temperature a few gas holes may develop later which were not visible in the first few days after making. Success in the making of Camembert cheese requires a rapid development of acidity, which with the rennet hastens the removal of the whey and tends to give the cheese a firm, elastic, healthy appearance.

### TEMPERATURE.

The temperature at setting should be from 82° to 86° F., depending upon the acidity of the milk, quantity of rennet, and condition of the milk. A high acid requires a low setting temperature, whereas a low acid requires a high setting temperature. The temperature is also somewhat dependent upon the method used. With an unbroken curd a high setting temperature may be used. When cheese is made by the French system, two or three separate settings of milk are desirable and in this case low temperatures are used with long setting periods. For example, the first milk is set at 85° F., and the last at from 82° to 83° F. This procedure favors a soft curd for the last dipping, which aids in giving the cheese a neat and attractive surface. If the last curd becomes dry and tough, the upper surface of the cheese does not rapidly assume the same evenness as the surface in contact with the drain mat.

[3] Marcel Montéran. Monographie et Fabrication du Fromage de Camembert. Librairie Agricole, Paris. Page 43.

### SETTING THE MILK AND ADDING RENNET.

In case the curd is neither cut nor broken, it is advisable to set the milk in several different batches in order that the curd may not suffer from prolonged action of the rennet before the curd is dipped. In this case about 50 per cent of the milk is set at first, and then at later periods 30 and 20 per cent. The quantity of milk set at each of these periods is dependent upon the rapidity of dipping. Usually from half an hour to one hour is allowed to intervene between settings. When warmed to the desired point, the milk is run into the setting cans or vats by gravity. Standard commercial rennet is added to the milk at the rate of 3½ to 4 ounces per 1,000 pounds, or about 10 to 12 cubic centimeters per 100 pounds. As the rennet sometimes varies in strength it is advisable to test its strength from time to time.

### CURDLING PERIOD.

The curd is ready to dip in from one to two hours. When a film of water collects upon the surface of the curd it is said to "sweat," a condition which indicates that the curd is fit to dip. Some latitude may be allowed as to the time of dipping without serious result. At this period the curd is smooth and shows no broken surface, and is but slightly drawn away from the setting cans. Often the setting period is prolonged from two to three hours, or even longer in the French process. The prevailing practice in this country is to use a much shorter period; from one to one and one-half hours is the usual limit. If large quantities of milk are handled it is advisable to reduce the rennet in some of the cases or vats, for fear the curd may become too hard and tough before dipping.

### ARRANGEMENT OF HOOPS AND MATS.

During the curdling period the hoops, boards, and mats are placed on the drain table. Drain boards for this purpose are of different sizes; some are 15 inches square, while others are rectangular in shape, 10 inches wide and 32 inches long. It is sufficient to wash the forms and mats daily unless there is trouble with foreign molds; in that case the equipment may be placed in a vat and boiled for half an hour. Mats should be quickly dried when not in use; otherwise foreign molds are more likely to develop on them and cause trouble when they are again used. At the beginning of each season all boards, mats, and forms should be carefully washed and heated in boiling water, for at this period there is most trouble with molds. After this treatment it is advisable to immerse the boards and forms in hot paraffin, which aids in preventing the curd from sticking to the sides. Unless the curd is broken or cut, the sticking is quite pronounced. Reparaffining is necessary whenever this film wears off. As soon as the cheese is removed the forms are brushed with warm water, rinsed, and quickly dried.

When used for the first few times the mats should be soaked in hot water; otherwise cheese is often broken by sticking to them. Where the boards and mats are 10 by 32 inches, 12 forms are placed on each board. Some makers use only one form, while others use a half form in addition to the regular form, which fits or slips over

the higher form and permits the cheese to be turned at an earlier hour. The half form permits the cheese to spread somewhat and aids thereby in giving it a uniform shape that more perfectly fits the shipping boxes.

### CUTTING THE CURD.

Cutting the curd, prior to dipping, by means of a special curd knife that readily conforms to the setting can or vat, is practiced in some factories with good results. This hastens the expulsion of whey and thereby makes it possible to turn the cheese at an early hour. When this system is followed the shape of the cheese is round and symmetrical and there is very little unevenness. Cheese from cut curd can be ripened at a higher temperature than would be practicable with cheese from unbroken curd. Often the cheese from cut curd has the appearance of being made from milk with a low percentage of fat and the texture is drier and harder than that of cheese

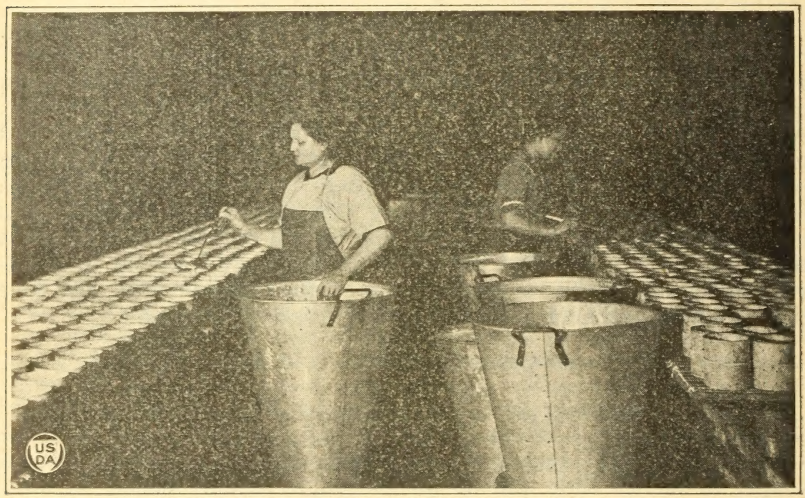

FIG. 1.—Filling hoops with curd by means of a dipper.

from uncut curd; it also has a longer marketable period. Cutting the curd prior to dipping hastens the expulsion of whey and appears to check somewhat a too vigorous development of Camembert mold; it also favors the growth of the reddish covering of microorganisms.

### METHODS OF DIPPING.

There are three methods commonly employed in dipping the curd:

1. Dipping the curd by means of a long-handled dipper, breaking it as little as possible. (See Fig. 1.)
2. Dipping the curd with a dipper and putting through a funnel into the form, with considerable breaking.
3. Dipping the curd after the entire mass of curd has been cut by means of a knife. Here the curd toughens somewhat in the whey prior to the dipping.

*Dipping the unbroken curd.*—By means of a small-handled dipper the curd is transferred to the forms with as little breaking as possible.

Two persons should empty a 200-pound can in 15 or 20 minutes. When the cans are emptied slowly there is always a tendency for the curd to be tough and broken before all the curd has been removed. The can containing the curd is mounted on a truck which may be wheeled from point to point without difficulty. The top of the can should be on a level with the top of the forms. Usually two dipperfuls of the curd are put into each form until all are filled, and then this process is repeated until all forms are filled. When this method is followed it takes only about two-thirds of the curd to fill the forms; the remainder is put into the forms as the first curd settles. Three or four fillings are necessary. After a little practice a person is able to estimate the time at which the curd is available for dipping and to regulate the time of setting accordingly.

A description of the multiple filler (Fig. 2) is given on page 15 and further illustrated in Figure 6.

FIG. 2.—Filling the hoops, using a multiple filler, by means of which six forms are filled at the same time. (See Fig. 6.)

It is essential that each cheese receive the same amount of curd; otherwise some will be too large and others too small. When too small the cheese dries out quickly, ripens abnormally, and does not fit snugly in the wooden shipping box.

### DRAINING.

The drainage should be conducted at a uniform temperature of from 65° to 70° F., with the air somewhat moist. The cheese itself aids materially in maintaining this condition of humidity. A rapid development of acidity causes the curd to settle in the forms quickly. By pushing the curd down along the sides of the forms the last thing before leaving at night no great difficulty is experienced with the curd adhering to the sides. When the curd is made on a large enough scale to justify turning the cheese at night, this trouble is largely obviated. If the curd is dipped in the morning, the higher forms may be removed by night and the cheese turned. When this procedure is followed the high forms are removed for washing, then

a clean, dry mat is placed on the lower forms, followed by a board. With one hand beneath, the position of the board is quickly reversed and the mat pulled off. If there is any tendency toward sticking, the end of the mat is turned back and pulled off as nearly parallel with the rest of the mat as possible. Such a precaution reduces the breaking of the surface to a minimum. At this period the cheese is $1\frac{1}{2}$ to $1\frac{3}{4}$ inches in thickness, and if it has not been turned the same day the upper surface will likely be somewhat dished. Several turnings tend to make the cheese symmetrical. If all operations have been carried out carefully, the cheese at the time of salting should possess a characteristic elastic softness.

### YIELD.

Camembert cheese should give a yield of 220 cheeses per 1,000 pounds of milk standardized to 3.5 or 3.6 per cent fat. The yield will depend somewhat on the period of the year, the total solids, and the size of package. Normally it requires about 2 quarts of milk to make one cheese. When marketed each cheese is usually guaranteed to weigh 8 ounces. Some factories, however, guarantee only 7 ounces. As a matter of fact, most of the cheeses on the market weigh nearer 10 than 8 ounces, because the manufacturers wish to be sure of full weight and a well-filled box. Some allowance should be made for shrinkage when the cheeses are wrapped in foil, but when they are reasonably dry this shrinkage is slight.

### SALTING.

The day after making, the cheese is salted at a temperature of from 65° to 70° F. with fine, dry salt. (Fig. 3.) The use of coarse salt is not objectionable, provided one becomes accustomed to its use so there is little danger of oversalting or undersalting. At this time the cheese feels moist and may be slightly greasy, but the surface should never have a crinkly appearance, which indicates too much *Oidium lactis*. Such a condition is also manifested by a disagreeable, offensive odor.

The salt is placed in a wooden box and two cheeses are salted at a time. The cheese is rubbed gently with salt and then some of the salt brushed away. It is essential that all parts of the cheese come in contact with salt. Each time the cheese is handled its position is reversed. This procedure not only tends to keep the surface dry but aids in giving the cheese its proper shape. A few hours after salting the cheeses with the boards supporting them are placed on suitable trucks, which often carry 50 to 60 dozen cheeses at a time, and are transferred to the curing rooms. The function of the salt is to establish a rind upon the surface, to dry the cheese, and favor the development of the Camembert mold and slime organisms, and to hold in check the putrefactive organisms. Undersalting may result in a cheese with a more offensive odor than when the cheese has been salted normally.

### INOCULATION WITH MOLD.

Various methods are used in inoculating Camembert cheese with mold. Some makers put the mold directly into the milk, others

sprinkle the cheese with a water culture of mold, while others put the mold into the salt. The disadvantage of putting mold into the milk seems to be that all surfaces of the cheese do not get a good development. Spraying the cheese with a water culture of the mold by means of an atomizer is an easy and efficient way of inoculating the cheese, as is also mixing some of the mold with salt. French makers claim that it is not necessary to inoculate with the mold after it is once established, for then the air and equipment have enough mold spores to inoculate the cheese without other inoculations.

It is always advisable to inoculate everything in the way of equipment and the rooms at the beginning of each season, or in places

FIG. 3.—Salting the cheese.

where the making operations have been suspended for a time. As regards the best method of establishing the mold much depends upon local conditions. Most manufacturers have found it advisable to inoculate daily. This seems especially true when the curd is cut or broken, for more trouble is experienced then in getting a quick and proper development of mold.

Too vigorous a development of mold should always be avoided, yet a fairly good growth is necessary to hold in check foreign molds and to give the cheese its characteristic flavor and texture. Under normal conditions the reddish slime will spread over the cheese in the course of 10 to 14 days, depending somewhat on the system of manufacture followed, temperature, and other conditions.

### GROWING MOLD FOR INOCULATION.

Camembert mold may best be grown on hard, dry, water crackers, rather than the common milk crackers. Fruit jars are filled about one-third full of crackers and then covered with a screw-top cover or plugged with cotton. Several of these jars are then placed in a dry sterilizer for about 1½ hours at a temperature of 150° C. By means of a sterile platinum needle the mold spores are then transferred from a stock culture to a flask of sterile water. Thom advises also the addition of 5 to 10 per cent of lactic or tartaric acid solution to the water before sterilizing. After cooling the crackers are moistened with the water containing the mold spores. The crackers should not be made soggy, but all of them should be moistened by rotating the jar about until all the water has been taken up.

Care must be taken not to contaminate the crackers with foreign molds, for this is much more serious than any bacterial contamination. The jars are then set away at a temperature of 60° F. A thick coat of white, cottonlike mold develops in the course of 10 days, which, when aging, turns to a green-gray color. When these colored spores develop it is an indication that the mold is ready to use. It is advisable not to use the mold until it has all changed color, for fear that some of the crackers may be contaminated with other molds, and this may not be evident at first. It is always desirable to use several extra jars, because under the best of conditions they sometimes become contaminated with foreign mold.

## FACTORY EQUIPMENT.

The equipment necessary for a Camembert-cheese factory should consist of the utensils common to creamery and cheese-factory work. A room for receiving and weighing, apparatus for testing the fat of milk, and steam for heating and sterilizing are all essential. A separator is also necessary to standardize milk and remove the fat from the whey. The sides of the room are best when cemented, for this tends to reduce to a minimum the accumulation of dirt and dust. The floors likewise should be made of cement with a gentle downward slope to a trap or drain to permit daily flushing. Wire netting of fine mesh to cover all windows is essential to guard against flies and insects. Unless all rooms are protected against flies there is danger that flies may lay eggs on the cheese and the eggs will hatch out later into maggots. When these skipper flies are in evidence in the draining room all cheese should be removed and the room thoroughly steamed for 1½ to 2 hours. When this method is followed all windows, doors, and other openings should be closed as tightly as possible. If it is impracticable to follow this procedure, fly swatters should be used until the flies are entirely eliminated.

Cheeses that have been infected by flies should be held at a low temperature, 50° F. if possible, for at a low temperature the eggs either fail to develop or develop very slowly. It is very essential that these precautions be carefully observed in warm weather, for otherwise these pests will cause no end of trouble. When the cheese becomes infected it should be scraped and then washed with salt water. Each room should be well lighted, for most of the curing rooms are either below ground or are completely inclosed.

### SPECIAL EQUIPMENT FOR THE "MAKE" ROOM.

Aside from the general equipment for the factory, special equipment is needed for making Camembert cheese, as follows:

*Tables.*—Table space enough should be available to accommodate the cheese from each day's make. Such tables are usually made of wood, but stone is better, although much more expensive. Each table should be at least 3½ feet wide. If made of wood the edges should be raised slightly to retain the whey escaping from the cheese; with stone a gutter around the edge conveys the whey to a desired point. The whey is then collected in a vat, where later it may be separated and disposed of to the best advantage.

*Aisles.*—The space between two drain tables should be wide enough to permit the passage of a truck with ease. Ordinarily the aisles are at least 42 inches wide.

*Dippers.*—Dippers should be provided with a bowl which easily slips into the forms. They may be made by a tinsmith. The bowl should always be more flat than round. Large dippers or scoops are used when the curd is cut or broken.

*Curdling cans or vats.*—Curdling cans, holding about 200 pounds of milk, are used in many American and most French factories. These cans are about 22 inches wide at the top, 12 inches wide at the bottom, and 26 inches high. Cans of this size are desirable in order that each batch of milk may be handled rapidly. The shape of the cans favors dipping without breaking the curd, as the bulk of the milk is nearer to the forms. Curdling cans may be made of 6X tin,

FIG. 4.—Truck for transferring cheese from one room to another.

with steel hoops at the bottom, riveted, tip wired, provided with handles, and with vertical seams at the bottom soldered.

Small, round-bottom vats, holding approximately 2,000 pounds of milk, are used sometimes as setting vats.

*Trucks.*—Curdling cans rest upon trucks which are provided with base rollers that move in any direction. (Fig. 4.) Cleats or an iron rim are placed in the top of each of these trucks so that the cans may be held in place.

*Drain mats.*—Some form of reed matting is desirable in order to facilitate rapid draining. Substitutes made of cloths have not proved very satisfactory. Formerly the mats were all imported from France, but now they may be purchased in this country. They consist of rattan or Chinese reeds, about one-eighth of an inch in diameter, bound together by threads. The size of the mats depends upon the size of the boards used for draining; the most common sizes are 10 by 32 inches and 16 by 16 inches. The need of having numerous small mats instead of one large mat is obvious. With the use of the small mats there is much less danger of breaking the surface of the curd and several cheeses may be turned at once.

*Hoops or forms.*—The number of hoops (often referred to as forms) should be the same as the number of cheeses to be made each day, with a few extra, for they occasionally become bent or otherwise unsatisfactory for use. If 500 cheeses are made it is advisable to have 600 hoops. Most manufacturers use a hoop 4½ inches in diameter and 5½ inches high. The diameter may vary one-eighth of an inch from these figures. Each hoop contains three rows of holes one-twelfth of an inch in diameter and 2 inches apart in the row. The edges of each hoop are turned and soldered. It has been found impracticable to use higher hoops because they are top-heavy and easily overturned.

Half hoops are used in some factories. Such hoops are 2½ inches high and 4⅝ inches in diameter, or just large enough to slip over the higher hoops easily. Each hoop contains two rows of holes one-twelfth of an inch in diameter and 1½ inches apart. The edges of these hoops also are turned and soldered.

*Drains and curing boards.*—Smooth, 1-inch yellow-pine boards 10 by 32 inches have proved satisfactory for both draining and ripening the cheese. The length of the boards may be longer or shorter to meet local conditions. These boards are wide enough to carry two rows of cheese and smooth enough to avoid the tendency of the cheese to stick. Ordinarily the drain boards are covered with mats which are just a little longer and wider than the boards. In the plant at Grove City, Pa., these boards serve the double purpose of curing and ripening both Camembert and Roquefort cheese.

In some factories corrugated boards are used without mats. These boards are 15½ inches square. The grooves are about one-sixteenth of an inch wide and of the same depth and about one-eighth of an inch apart. These boards will hold nine cheeses, and while somewhat more expensive and not so easy to clean as the plain boards, yet with their use no drain mats are required.

*Cane bottoms; open boards.*—Because of the difficulty in obtaining "clayons" or mats, which were formerly used in order to favor development of the Camembert mold, cane bottoms or open boards have been tried and found to be satisfactory substitutes. The cane bottoms consist of square framework 15½ inches square, made of ½ by 1 inch material. The corners of the framework are dovetailed together and covered with canework, as shown in Figure 5. Provided

there is not too great a development of the Camembert mold, the cane bottoms may serve throughout the entire curing process. Open boards are used for the same purpose, and consist of the following material: Eleven ⅞ by 1 inch pine strips 32 inches long and two strips of the same material 10 inches long, the latter serving for end pieces. The strips are joined together and their edges serve as a base upon which 12 or 14 cheeses may rest.

*Cheese filler.*—A multiple filler, which saves much time, is constructed so that six or nine forms can be filled at the same time. The curd is dipped without being cut by means of a large dipper and poured into the filler, where it finds its way to the various forms through the separate compartments of the filler. (Fig. 6.)

The filler is 15 inches square, with sides 1½ inches high extending around the outer edge of the filler. The sections or compartments are 5 inches square and have a 2-inch slope from the middle edge and a 3-inch slope from the corner of the compartment. Both these slopes slant toward the middle, where a hole 2¼ inches in diameter, with a spout of same diameter and 1½ inches long, is located so the curd will run into empty forms. On the underside, on both sides of the filler, are strips of tin 12 inches long and 1½ inches wide that allow the filler to rest evenly on the forms, so that it does not slide, thus preventing any spilling of the curd. This filler may be made of either galvanized iron or tin and be designed to fill any number of forms.

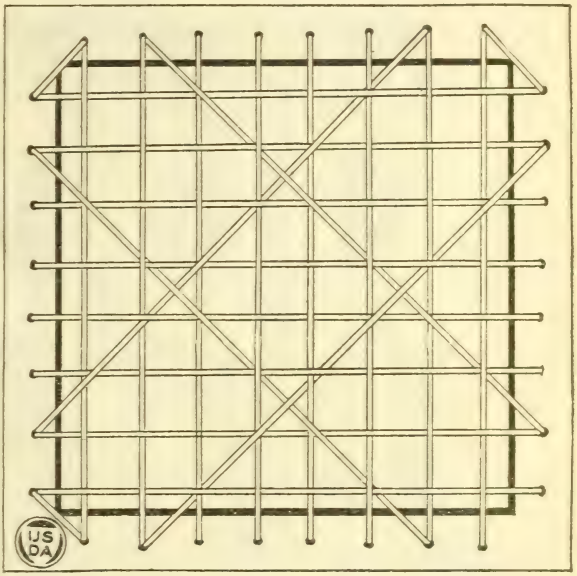


FIG. 5.—Cane bottom for ripening cheese.

### CONSTRUCTION AND EQUIPMENT OF RIPENING ROOMS.

It is advisable to have well-insulated curing rooms and special conditioning apparatus in order to regulate carefully the curing conditions for this cheese. In the plant at Grove City, Pa., the sides, top, and bottom of the curing rooms have been insulated with 4 inches of cork laid in hot asphalt and covered with Portland-cement plaster. By the use of such equipment it is possible to minimize sudden changes of temperature and make curing conditions regular and uniform. In many factories the cheese is ripened in cellars entirely below ground. Other factories patterned after the French

factories are entirely above ground. In either case means are provided for controlling the ventilation. With the factories above ground there are numerous openings (small windows) at different heights so that the circulation of air may be regulated. The direct rays of the sun should never fall upon the cheese for fear of injury to the mold. When this happens the mold will often take on an abnormal pink or reddish color. The only feasible way known to bring about a continuous drying is by means of a fan, such as is described in connection with the conditioning apparatus. There is little use of considering the relative humidity of a curing room without taking into consideration the rate of air change as well.

*Conditioning equipment.*—Several years' experience has proved the inefficiency of the ordinary means of controlling humidity for mold-

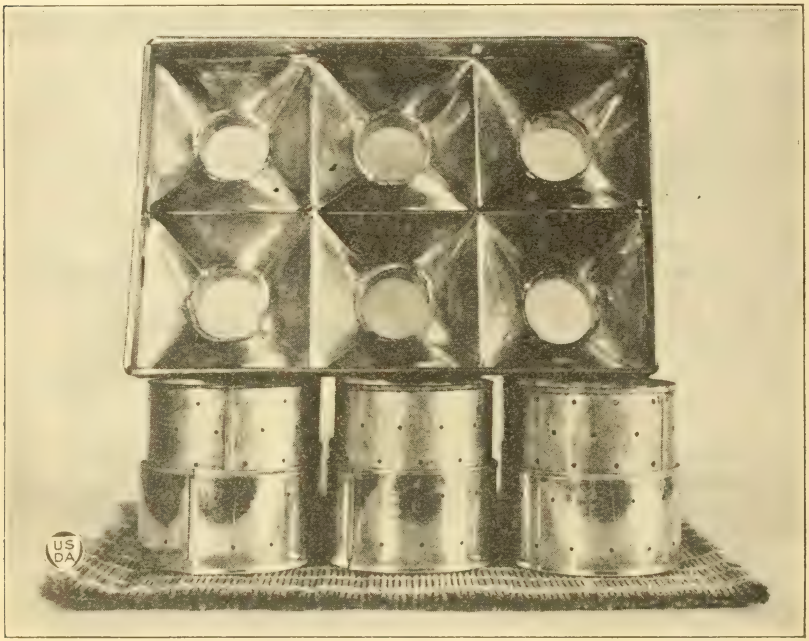

FIG. 6.—Multiple filler for putting curd into hoops. Also mat and hoops.

ripened cheeses. With the use of proper refrigeration no great difficulty has been experienced in adjusting the temperature to the desired point. To hold the temperature at a low point and still maintain a high humidity is more difficult. Cooling Camembert curing rooms by means of direct expansion or brine coils has been unsuccessful. With such a system moisture is continually removed from the cheese and it becomes too dry. Cheese handled in this manner ripens slowly, surface molds fail to develop properly, and the flavor and texture are impaired.

*Air conditioning.*—Air conditioning has been used in other industries to regulate artificially the atmospheric conditions of a room or building and to maintain and regulate certain desirable and definite conditions of humidity, temperature, and air purity. So far as is

shown by literature, no one has adopted this method of conditioning the air for curing cheese. It is desirable not only to regulate cheese-curing conditions but to prevent the mold from one curing room mixing with the air of another. There is little danger of such a condition causing trouble with Roquefort cheese. However, it is quite possible that the air from a Roquefort room might contaminate the air in a Camembert room.

The system for regulating temperature and humidity used in our curing rooms includes an air washer with a fan for circulating the cooled air in a closed circuit through the rooms. The air washer consists of a series of sprays through which the air is drawn on its return from the room. The washer is so arranged that water from the sprays flows over direct-expansion ammonia coils which cool it to about 32° F. Below the coils is a storage tank from which the water is forced through the sprays by a rotary pump. Between the sprays and the fan is a series of baffle plates to remove the entrained water. Insulated ducts carry air into the curing rooms through the ceilings. Two inlets are provided for a room 11 by 19 feet. The temperature of the room is held constant by dampers on the inlets operated by compressed-air motors. These motors are regulated by a thermostat. Four outlets in the ceiling of each room connect with a common duct which returns the air to the washer.

The system insures a thorough circulation of air within the room. By this arrangement the air leaves the air washer at a temperature of from 40° to 45° F. and in a saturated condition. As it mixes with the warmer air of the curing room the relative humidity drops, and it is necessary in some cases to bring it to the desired point by introducing additional moisture. This is done very satisfactorily by throwing a jet of steam into the current of air as it comes into the room. This steam is carried under very low pressure and may be regulated by hand so that the relative humidity is held within narrow limits. The steam is at once absorbed by the air, and while it adds a small amount of heat, it has given very satisfactory results.

*Equipment of ripening rooms.*—For ripening Camembert cheese an open, light framework is essential to support the curing boards. This framework consists of a series of 2 by 2 or 2 by 4 inch posts joined at the floor and ceiling. Crossbars of 2 by 2 inch material from 6 to 8 inches apart connect these posts. In large factories there are numerous aisles 5 or 6 feet wide so that all the cheese is in reach from two sides.

### DRYING MACHINE.

A great many of the larger Camembert plants use a machine for drying the mats. One type of dryer has steam coils along the sides and near the bottom. The sides, top, and bottom are of pine wood, lined with lapped block tin and a layer of asbestos between wood and tin to retain the heat. Attached to an iron frame is a track and countershaft on which is a conveyer that runs on a single track, and is used for handling the mats. The hooks, hanger, and track are rustproof and do not discolor the mats nor the cloths which often are dried this way.

The dryer for drying Camembert mats at the Grove City creamery is one that was designed to suit the special needs of the plant, and is

used in connection with drying Swiss-cheese cloths and Roquefort-cheese mats. However, this dryer can be designed to suit the requirements of a factory of any size and it can be erected at a very moderate expense.

The dryer at Grove City is 10 feet long, 3 feet wide, and 3 feet high. At the front is a hole 17¼ inches in diameter, just large enough for an electric fan to fit snugly into it so that the hot air which comes from four rows of 1-inch steam piping placed perpendicularly in front of the hole can be fanned among the racks where the wet mats are hung on wooden rods to dry. The racks are 3¼ feet long and open from the top by means of hinged covers. The front of the dryer where the fan and steam pipes are located is lined with galvanized iron to keep the hot air in. The rest of the dryer, except frame and covers of drawers, which are made of wood, is wall board.

## THE RIPENING OF CAMEMBERT CHEESE.

In most factories the cheese is made on the ground floor and then carried to a second-floor room or the basement for ripening. The manner in which the cheese is made is probably as important a factor in regulating the proper surface vegetation as the curing conditions themselves. When the cheese is made by the uncut-curd method more difficulty is experienced in removing the excess moisture from the cheese, and ample means must be provided for ventilation. If the curd is broken, less precaution is necessary in drying, but more difficulty is experienced in developing the needful Camembert mold.

Sometimes the cheese is held for one day in the drain room after salting; at other times it is salted and taken to the curing room at once on the day after making. If salted in the morning, it is allowed to remain at room temperature for a few hours and is then carried to the curing room. Because of the repeated turnings (Fig. 7), a considerable proportion of the moisture should have escaped from the cheese, and it should have acquired considerable firmness due to the salting. At this time the cheese should appear somewhat moist, although the condition should not have developed to such a point that the cheese is greasy or ill smelling. It should have an acid but clean odor.

After salting, the cheese remains on open ripening boards. If no difficulty is experienced from an overdevelopment of mold, it may be allowed to remain on the cane bottoms throughout the entire curing process. With the cane bottoms it is not necessary to turn the cheese so often as with the smooth boards, for there is less danger of breaking the surface.

### OIDIUM RIPENING.

*Oidium lactis* is a type of organism that may spread over the surface in 24 hours and is the one organism more responsible than any other for giving the Camembert cheese a putrefactive tendency. When the rooms are very warm, 75° F. or over, and the humidity is high and there is little or no ventilation, this organism develops very rapidly, and may spread itself over the cheese before salting. Organisms of this type are nearly always present in milk products, and in limited quantity may not be harmful, but a vigorous development of this growth is to be avoided. If the milk is old, or if the cheese

drains abnormally slowly, there is more likely to be a fermentation of this character. At other times this fermentation may not appear until several days later. This condition, however, is more rare. When great difficulty is experienced in handling this organism, the forms, mats, and drain boards should be held in water as nearly as possible to the boiling point for an hour, and every possible precaution should be taken to keep the drain tables and other equipment scrupulously clean.

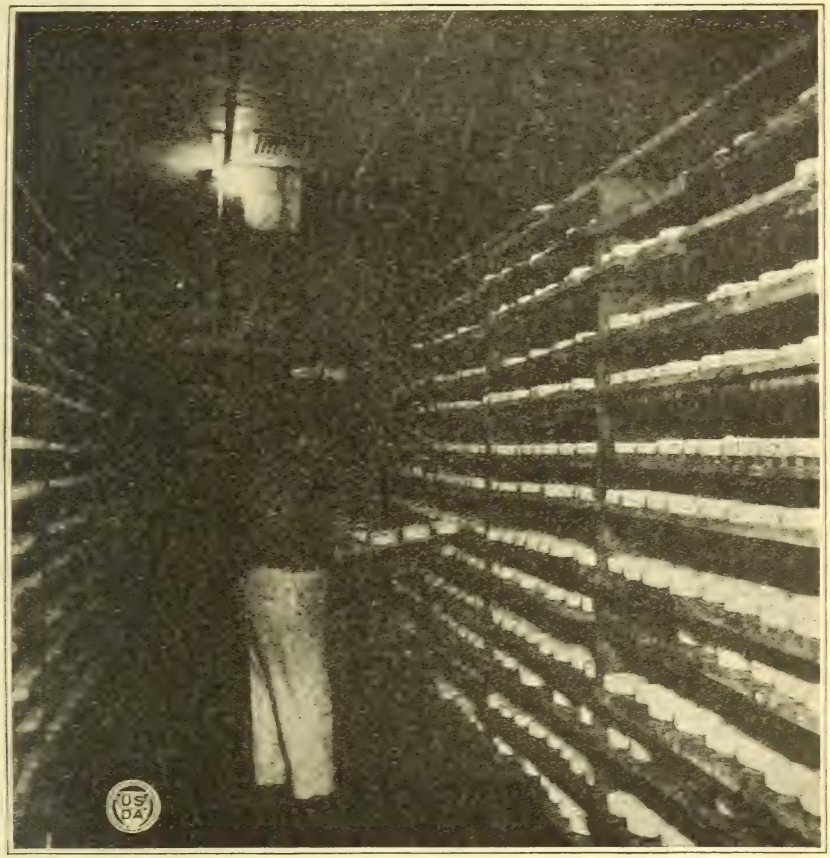

FIG. 7.—Turning cheese in curing room. Humidifying apparatus attached to ceiling.

Salt checks the development of oidium and renders its injurious effects less obnoxious. For this reason the average Camembert cheese should contain about 2½ per cent of salt when ripened. The cheese should always be salted before this organism makes too much headway or the gelatinous surface growth will interfere with the proper absorption of salt. Such a fermentation develops a soft, irregular rind which breaks and peels easily and unless great care is taken the cheese may be a total loss. A liquid layer quickly develops beneath the coat of this organism and as a consequence the Camembert mold makes less development than it would without this softening effect.

At times it is almost impossible to grow the Camembert mold and the surface of the cheese takes on a reddish color, not at all desirable at this stage of the ripening. While it is true that the cheese may be ripened beneath despite the action of this organism, the appearance of the cheese is not attractive, the flavor is impaired, and a putrefactive odor is in evidence. When the oidium fermentation supersedes the normal Camembert fermentation it is desirable to keep the air in as dry a condition as possible and thereby encourage the development of the Camembert mold. If the oidium has not made much headway the Camembert mold can be induced to grow and eventually cover the cheese and thereby reduce the injurious effects. A slight growth of oidium, provided it does not go too far, is desirable in preventing a thick, feltlike growth of the Camembert mold.

#### CAMEMBERT-MOLD RIPENING.

In five or six days after inoculation, depending on the temperature, the cheese shows slightly brown spots of Camembert mold. After it is put in the curing room this is followed by small white patches of mycelium of the Camembert mold. Unless too great a development of the *Oidium lactis* mold is present the network of mycelium spreads rapidly over the surface of the cheese and in the course of 10 to 14 days the presence of colored spots caused by the Camembert spores is noticeable. The coloring appears to develop more rapidly on the edge than on the surface of the cheese, due, possibly, to the mold being held somewhat in check by repeated turnings. If the cheese is kept on open boards it is removed and placed on smooth ripening boards. Prior to this the cheese should be turned daily in order that the strips of wood may not cut into the cheese and that the surface of the cheese may not be broken by sticking. When the Camembert mold is once established it develops with surprising rapidity, especially with the unbroken curd, and efforts must be made to check too luxuriant a growth.

#### "FERMENTS ROUGES," OR RED GROWTH.

A red or yellow color on the surface of the Camembert cheese, due to bacteria, yeasts, and mycoderma, is usually taken as an indication of good quality. While there may be some doubt as to whether or not the surface organisms actually hasten the ripening of the cheese or improve its flavor, it is desirable that the growth should gradually spread itself over the Camembert mold so that when marketed there should be only spots showing the Camembert mold. At the time the red slime begins to develop the growth of the Camembert mold gradually ceases, and the reaction of the surface tends to be alkaline instead of acid. The reddish growth is at least a good indication that the cheese has been ripened under proper curing conditions. This slimy growth not only tends to check too luxuriant a growth of the mold, but it is said to form a protective coating which prevents access of air to the cheese and thereby checks the likelihood of flavors and odors of rancidity.

Mazé, of the Pasteur Institute, advises inoculating the curing equipment with these surface organisms. Our experience has led us to believe that it is advisable to inoculate with these organisms at least at the beginning of the Camembert season or in new curing

rooms. Should these organisms fail to develop after several months, it is advisable to inoculate again. A room which contains a large number of cheeses with a high humidity and little ventilation seems to favor the development of this surface fermentation. In factories where the cheese is made continuously the year round no great difficulty is experienced in developing surface slime.

In inoculating with these organisms skim milk is heated to the boiling point for half an hour and then cooled to 70° F. and the culture added. After it has stood for two days the mats, boards, and cane bottoms are thoroughly sprinkled with the liquid culture.

### FOREIGN MOLDS.

Foreign mold may contaminate Camembert cheese and cause it to be sold at a reduced price. Yeast and bacteria may be present in large numbers, but seldom if ever do these organisms exert any very harmful influence upon the cheese. Green molds, sometimes the Roquefort mold (*Penicillium roqueforti*), become numerous in factories and give the cheese a very unattractive appearance. Often these foreign molds impart unpleasant and bitter flavors to the cheese. According to Thom, the most troublesome of these molds are *Penicillium brevicaule* and two closely related varieties, which give off a strong ammoniacal odor. If allowed to grow unrestricted and with proper curing conditions the Camembert mold will gradually crowd out the obnoxious molds.

Even under the best conditions foreign molds are always present, and they can be held in check only by scrupulous care in keeping equipment clean and regulating the curing conditions. The greatest trouble with foreign molds is experienced in the beginning of the season, when factories are just beginning to operate. When the cheese is made continuously this difficulty is seldom experienced. Before the start in each season it is advisable to clean and wash up all curing rooms, walls, and equipment and, wherever possible, to steam out the curing rooms for a few hours. All equipment possible should be boiled in water an hour or put into a sterilizer and sterilized and then quickly dried.

The mold spores are very light and may be carried by dust particles to the cheese, so the curing rooms should be kept moist to reduce the chance of contamination to a minimum. The use of chemicals, formaldehyde gas, for example, has not been entirely successful as a means of eliminating foreign molds, although it aids in reducing them. No practical measures have been evolved which will eliminate them completely in the draining and curing rooms. Where they have become established in factories the best thing to do is to sterilize the equipment, keep the curing rooms moist, and reinoculate with Camembert mold by spraying a week or so before beginning the manufacture of cheese. This may be done with an atomizer. All parts of equipment that come in contact with the cheese, as well as the walls, doors, and windows, should be sprayed.

### CONDITIONS OF RIPENING.

The ripening of Camembert cheese should be conducted in a manner to favor the proper flavor, texture, and appearance. As the

cheese comes from the salting process, it should have a certain firmness, and in the course of a few days should take on a greasy appearance and emit a yeasty odor. The curd should taste acid, and Marre[4] says it should give off an odor as of well-ripened apples. The mold develops and is followed by red slime. The cheese is then dried to a point suitable for marketing and boxed, and by this time should have ripened to a depth of about one-fourth inch. When the cheese is boxed in from 12 to 15 days not so much attention is required in controlling the curing conditions. Provided the factory is properly constructed for curing this cheese, no great difficulty should be experienced in handling it. In cases where the curing rooms used are not well controlled a clear understanding of the factors concerned in the curing of the cheese is more essential. There are three factors which affect the manufacture of an excellent Camembert cheese—the temperature, the relative humidity, and the ventilation.

*Temperature.*—Camembert cheese should be ripened at a temperature of from 52 to 58° F. In factories where refrigeration is not available and the curing conditions are more or less subject to climatic conditions, the difficulties of making this cheese are greatly increased. Under such circumstances the cheese is made only in the colder months, and the temperature is brought to the desired point by means of steam pipes. In general, the temperature should be higher in the initial stages of curing than later, when the curing organisms have reached their maximum development. All efforts in the initial stages of ripening are directed toward the establishment of a healthy growth of the Camembert mold. This can best be accomplished at a temperature of 55 to 58° F. As the curing progresses a lower temperature, from 50 to 52° F. is desirable. This temperature should be maintained after the cheese is placed in boxes and crated.

*Relative humidity and ventilation.*—The relative humidity and ventilation are varied according to the moisture content of the cheese and the stage of ripening. Formerly much of the Camembert cheese made in this country was ripened in rooms which depended upon open windows to dry out the cheese to a point suitable for shipment. With the uncut curd the mold appears to develop more rapidly than with the cut curd, and there is always a tendency for the mold to to form a heavy coating; consequently much more attention must be given to removing the excess whey from the cheese. Where refrigeration is lacking and where the curing rooms have not been constructed for the purpose of handling Camembert cheese, the factors of relative humidity and ventilation are of great importance.

Most of the modern equipment is provided with refrigerating machinery and special curing rooms, and as a consequence the ripening conditions are far less difficult to regulate. When made on a large scale, the cheese itself aids materially in maintaining a high humidity, and little difficulty is experienced in this respect. This is especially true when the cheese is cured in the basement of the building. A certain amount of ventilation is desirable, yet under certain conditions this may be so great as to cause the cheese to be hard and dry. The French recommend the use of several rooms for curing the

[4] Francis Marre. Le Problème Juridique de Camembert. Éditions Scientifiques Françaises, Paris, 1915. Page 28.

cheese, with varying degrees of moisture and ventilation. In the United States one large room or at least two smaller rooms are employed in handling the cheese. In factories where refrigeration is not available considerable difficulty is experienced in handling the cheese, and it can be made in a satisfactory manner only in the fall, winter, and spring months.

With the uncut-curd method used in France the conditions shown in Table 4 are advised by Montéran [5] for handling the curd. Where the cheese is ripened under these conditions several rooms are used.

TABLE 4.—*Physical conditions for making Camembert cheese from uncut curd (according to Montéran).*

| Period. | Temperature. | Humidity. | Ventilation. | Mold development. |
|---|---|---|---|---|
| | °F. | | | |
| First period, 4 days.... | 59 | Considerable.. | Very little..... | Starting of penicillium in an acid medium. |
| Second period, 10 to 12 days. | 54.4–57.2 | Moderate..... | Moderate..... | Development of penicillium in acid medium. |
| Third period, 2 to 4 days. | 54.4 | Low..... | Very active... | Termination of the penicillium; the acid has disappeared, the medium is alkaline, and the cheese becomes firm. |

After the cheese is fully cured a low temperature, of from 50° to 52° F., is advised until the cheese is consumed. A high relative humidity possibly would be 88 to 92 per cent, a moderate humidity 85 to 88 per cent, and a low humidity below 85 per cent.

Where Camembert cheese is made under the French system it has a waxy texture, and the imported cheeses are most often ripened all the way through. The cheese usually has an excellent flavor, texture, and surface appearance. The average domestic cheese is ripened possibly two to three weeks in the factory and is then boxed. When the rapid system is used in curing, the cheese suffers somewhat in texture and flavor, and usually does not have the keeping quality that it has when the curd is ripened more slowly and dried more thoroughly.

## WRAPPING AND BOXING.

In many factories the cheese is removed from the ripening boards in less than two weeks and wrapped in parchment paper, or parchment paper and foil, and then placed in small, round boxes. Aluminum foil has been found as satisfactory as tin foil, although some makers prefer to use tin foil because of its superior strength. Ordinarily aluminum foil may be purchased more cheaply than tin foil. By placing the cheese in boxes its shape is maintained and any inequalities that remain from the draining process are removed. Parchment paper, while cheaper than the foil, permits the cheese to dry out slightly, and if the cheese is not in good condition the paper may be broken and result in a very unattractive appearance. More complaints have been received where parchment paper has been used instead of foil, because the cheese is too dry and fails to ripen normally. One advantage in the use of parchment paper is that the extent of

[5] Marcel Montéran. Monographie et Fabrication du Fromage de Camembert. Librairie Agricole, Paris. 1908. Page 67.

red and blue mold development can readily be determined by looking through the paper without unwrapping it, as would be necessary with tin foil. Most of the cheese on the market is wrapped in both parchment paper and foil.

After wrapping, the temperature of the cheese often rises several degrees, due to a more rapid fermentation than when it is exposed to the free air. At time of boxing the cheese should be dry enough so that no whey will escape later. Wrapping the cheese too wet may

FIG. 8.—Wrapping and crating the cheese.

cause a strong, biting flavor and give the surface a very undesirable appearance.

By the time the cheese is wrapped the Camembert mold has practically ceased to develop, while the slimy coat spreads itself over the surface. In most cases the major part of the ripening process occurs after the cheese is boxed. The drier the cheese the higher the temperature at which it may be ripened. Very hard, dry cheese may be ripened in foil and boxed, whereas considerable difficulty would be experienced in ripening such cheese without that treatment. The small, round boxes are then placed in light crates, 5 dozen to the crate, and each crate nailed and wired.

## COST OF MANUFACTURE.

Figures given below on the cost of manufacture, as estimated in 1922, are based upon experience in the work on a commercial scale. Milk standardized to 3.5 to 3.6 per cent fat and valued at $2.25 per 100 pounds is used in these calculations. The daily costs of water, fuel, electricity, repairs, and depreciation are an engineer's estimate. The yield of cheese is figured at 220 cheeses per 1,000 pounds of milk. The cheese is assumed to be sold in the customary 5-dozen crates. The labor is figured on the basis of cost of labor together with a proportionate cost for supervision. The costs of aluminum foil, boxes, and crates as given are actual costs when these items are purchased in quantities.

These estimates are based on the assumption that curing rooms run at maximum capacity and do not take into consideration losses which may occur in marketing a perishable product. The figures represent a minimum cost, dependent upon a maximum scale of manufacture. When the cheese is not made on a large scale the charge for many items of expense is increased. Such a condition may be responsible for a variation of several cents per cheese. The price of milk, overhead charge, and size and style of package may cause considerable variation in the cost of making one Camembert cheese.

TABLE 5.—*Estimated cost (in 1922) of making one Camembert cheese on a commercial scale.*

| Item. | Cost. |
|---|---|
| Milk | $0.1023 |
| Labor for receiving and testing milk | .0003 |
| Salt and rennet | .0007 |
| Labor in making | .0197 |
| Curing charge | .0077 |
| Aluminum foil | .0065 |
| Box | .0200 |
| Losses from broken boxes | .0027 |
| Crates | .0033 |
| Labels | .0033 |
| Administrative charge | .0101 |
| Interest on money invested in building, equipment, insurance, taxes, repairs, and depreciation | .0075 |
| Total | $0.1841 |

## WHOLESALE AND RETAIL PRICES.

Both wholesale and retail prices of Camembert cheese have advanced materially since the war period. Little of this product was imported during the war. In November, 1922, this cheese was selling wholesale at about $3.25 to $3.75 a dozen. Since the World War, the price of domestic Camembert has nearly doubled and the demand has constantly increased. Good Camembert retails at from 35 to 50 cents a cheese. The price does not appear to fluctuate so readily as that of many varieties of soft cheese.

The variation in price of Camembert cheese from 1900 to 1922 is indicated in Table 6. Records were not always available for 12 months in the year. After 1916 no quotations were available for foreign cheese up to the beginning of 1923. These figures were taken from a New York trade journal, and give the wholesale

price per cheese at New York. As practically all importations come through that port and as it is the chief distributing point, these quotations are assumed to show the state of the market.

TABLE 6.—*Average annual wholesale price of Camembert cheese (half-pound package) in the United States, 1900 to 1922, inclusive.*

| Year. | Imported Camembert. | Domestic Camembert. | Year. | Imported Camembert. | Domestic Camembert. | Year. | Imported Camembert. | Domestic Camembert. |
|---|---|---|---|---|---|---|---|---|
| | *Cents.* | *Cents.* | | *Cents.* | *Cents.* | | *Cents.* | *Cents.* |
| 1900 | 26.8 | ..... | 1908 | ..... | 19.1 | 1916 | 31.6 | 21.6 |
| 1901 | 21.6 | ..... | 1909 | 20.8 | ..... | 1917 | ..... | 26.0 |
| 1902 | 21.2 | ..... | 1910 | 20.8 | 18.3 | 1918 | ..... | 31.4 |
| 1903 | 21.6 | ..... | 1911 | 22.9 | 17.6 | 1919 | ..... | 32.5 |
| 1904 | 21.6 | ..... | 1912 | 21.6 | 17.1 | 1920 | ..... | 33.3 |
| 1905 | 21.6 | ..... | 1913 | 21.3 | 16.6 | 1921 | ..... | 33.3 |
| 1906 | 21.6 | ..... | 1914 | 21.6 | 17.8 | 1922 | ..... | 31.4 |
| 1907 | 20.5 | ..... | 1915 | 26.0 | 19.7 | | | |

## SOME ECONOMIC FACTORS.

As a matter of general policy it is often advisable to establish a cheese factory in conjunction with the manufacture of other dairy products. Having another product, butter for example, for which there is generally a good market the year round, makes it possible for a factory to utilize the milk to the best advantage throughout the year. In small plants, especially where refrigeration equipment is not available, the making of Camembert cheese is difficult during the summer months; consequently there is a supply of milk during certain periods of the year that can not always be used to advantage.

The chart, Figure 9, shows the production of Camembert cheese at the Grove City (Pa.) creamery during the season 1920–21. The curve shows that the production is at its apex during December, January, and February, and has a tendency to decline during March and still more in April. When warmer weather comes the manufacturing is usually suspended because of difficulties in shipping and trouble due to flies.

The necessity of good shipping facilities can not be too thoroughly emphasized. It is always advisable to ship by express rather than by freight, for the latter offers too many uncertainties. It is advisable also to ship by the most direct means. Whether the matter is considered from the standpoint of preventing overripeness or from that of having the cheese reach the consumer in the most attractive condition, when cheese is too long on the road the marketable period for the wholesaler and the retailer is shortened.

The wholesale price of domestic Camembert cheese in 1920 to 1921 was the highest on record. When prices were lower American manufacturers were unable to compete in either quality or price with the cheese sent from Europe. The shutting off of practically all imported cheese, together with prevailing high prices, enabled American manufacturers to gain the necessary experience in perfecting this kind of cheese. The quality of our domestic cheese has improved so much in the last few years that it will probably be much more difficult for the foreign cheese to become reestablished in American markets. The average wholesale price of the im-

ported cheese for five years before the war was 12.8 cents per cheese. This price, plus the freight and duty charges, would make the cost about 15½ cents f. o. b. New York.

Losses occur frequently in the manufacture and marketing of Camembert cheese. Under the best of conditions losses may occur through overripeness, mold contamination, or injury in transit. With proper curing conditions and adequate marketing facilities these losses should be reduced to less than 3 per cent. The fact that the cheese is extremely perishable is partially offset by the shortness of investment period, for the cheese is seldom held at the factory for even so long as a month before shipment.

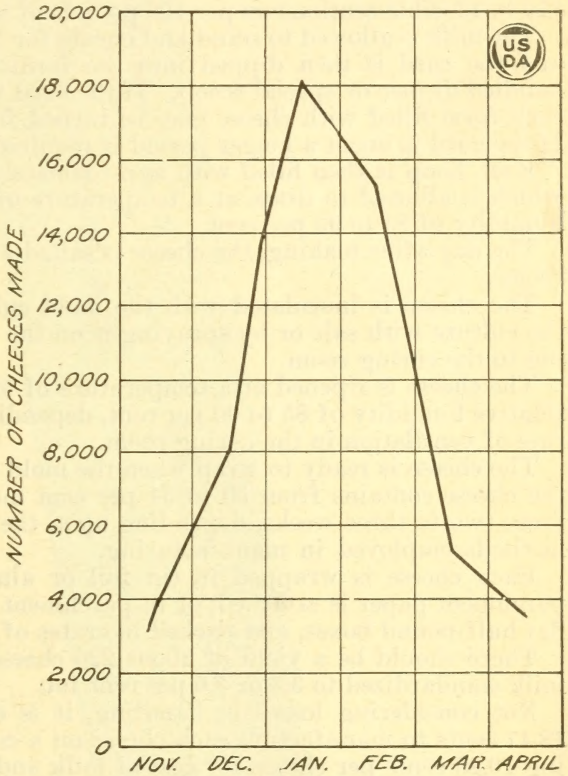


FIG. 9.—Typical seasonal production of Camembert cheese at the Grove City (Pa.) creamery (1920–1921).

## MAKING CAMEMBERT ON THE FARM.

Little if any Camembert cheese is made on farms, yet this is a common practice in France. Probably there are many who, if they would take the necessary pains and care, could develop a fairly satisfactory product on the average farm without a great expenditure in the way of equipment. The possibility exists of making cheese suitable not only for home consumption but for local trade as well. Where the cheese is made for local trade it is advisable to use the cut or broken-curd process, and to pack in the regular boxes and foil, and in general to handle the cheese in the same manner that it is handled in the factory. It is believed that a cellar, refrigerating box, or milk house could be utilized for making this cheese. When it is made in a small way there is, of course, more difficulty with foreign molds, also more difficulty in developing red slime, and the mold is more likely to be too thick; nevertheless it is believed that a cheese can be developed with as good flavor and texture as that made in factories. It must be remembered that many people are not familiar with this kind of cheese, and where it is made to sell, a local trade can be built up only gradually.

## SUMMARY.

In making Camembert cheese, fresh, clean milk is standardized to 3.5 or 3.6 per cent fat.

From 1 to 2 per cent of a freshly made and vigorous starter is added, and the milk is allowed to ripen until it has an acidity of 0.20 to 0.23 per cent calculated as lactic acid.

The milk is then warmed to a temperature of 84 to 86° F., and rennet is added at the rate of 3 or 4 ounces per 1,000 pounds of milk (10 to 12 cubic centimeters per 100 pounds of milk).

The milk is allowed to stand and curdle for 1 to 1½ hours or longer, and the curd is then dipped into the forms by means of a long-handled dipper or special scoop. If the curd is cut prior to dipping, each form filled with cheese may be turned four or five hours later. If the curd is uncut a longer period is required.

Each hoop is then filled with approximately 2 quarts of the curd, which is allowed to drain at a temperature of 65° F. and a relative humidity of 85 to 90 per cent.

The day after making, the cheese is salted and taken to the curing rooms.

The cheese is inoculated with the mold culture either by mixing the culture with salt or by spraying it on the cheese just before taking to the curing room.

The cheese is ripened at a temperature of 52 to 58° F. and with a relative humidity of 85 to 90 per cent, depending somewhat upon the rate of ventilation in the curing room.

The cheese is ready to wrap when the mold is well established and the cheese contains from 50 to 54 per cent moisture. This requires from two to three weeks, depending upon the curing conditions and methods employed in manufacturing.

Each cheese is wrapped in tin foil or aluminum foil, to which parchment paper is attached, or in parchment paper alone, placed in flat half-pound boxes, and packed in crates of 5 dozen each.

There should be a yield of about 220 cheeses per 1,000 pounds of milk standardized to 3.5 or 3.6 per cent fat.

Not considering losses in handling, it is estimated that it costs 18.41 cents to manufacture each cheese on a commercial scale, allowing 10.23 cents per cheese for cost of milk and 1.97 cents for labor.

The wholesale price of Camembert cheese is from $3.25 to $3.50 a dozen. Each cheese retails at from 35 to 50 cents.

Camembert cheese is made mostly in the fall, winter, and spring months. The greatest demand for the cheese is in January and February.

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